Role of Mobile Agents in the Future of the Internet

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ABSTRACT: ***With the appearance of the World-Wide Web, the use of the Internet has exploded in recent years. In this paper, we illustrate how current technological developments will lead to a mobile code-based system and, in many cases, mobile agents. In the road to that eventuality, we address some technological and non-technical barriers. It seems likely that almost all major Internet sites will be able to host and willing to host some sort of mobile code or mobile agents within a couple of years. The Internet didn't exist forever; in the 1970s and 1980s, it was developed by humans. Then we kind of watched it grow as it grew, trying to hold on and making sure it kept running. It seems very clear that the drive to keep the Internet running is immense, as long as technology continues to exist at something at least close to today's standard. There's a very, very useful Internet. However, to keep running, the Internet relies on quite a bit of technology. To keep it alive, we need power, laptops, semiconductors, apps, and ultimately a working high tech industry.***

KEYWORDS: ***Mobile Agents in the Context of Competition and Cooperation (MAC3), Mobile Devices, Proxies, Portability, Standardization.***

INTRODUCTION

The rapidly evolving network and computer technology, coupled with the exponential growth of the services and information available on the Internet, will soon bring us to the point where hundreds of millions of people will have easy, omnipresent access to a phenomenal amount of information, through work, school and home desktop computers, televisions, phones, pagers, and car dashboards, from a phenomenal amount of information In order to facilitate such access, mobile code, and in particular mobile agents, will be an important tool [1]. Mobile agents are programmes that, at times and in locations of their own choice, can switch from host to host on a network. In the Workshop "Mobile Agents in the Context of Competition and Cooperation (MAC3)" at Autonomous Agents' 99, on May 1, 1999, the condition of the running programme is saved, transported to the new host, and reA significantly similar paper appeared as a position paper [2]. For the authors, copyright stays. Stored, making it possible for the software to resume where it left off. Mobile agent systems vary from process migration systems in that the agents move when they want, normally via a "jump" or "go" statement, while the system determines when and where to move the running process in a process migration system (typically to balance CPU load). Mobile agents are distinct from applets, which are programmes that are downloaded as a result of a user intervention, and executed on one host from start to finish.

For many factors, mobile agents are an efficient alternative for several applications, including improvements in client-server device latency and bandwidth and reducing network disconnection vulnerabilities. While not all applications will require mobile agents, for all or part of their tasks, many other applications will find mobile agents the most powerful deployment technique. While we agree that the usage of mobile agents is the product of current developments in internet technology and use, many technological and non-technical obstacles need to be tackled along the way. These barriers pose important but not insurmountable challenges, so we expect that mobile agents will be approved by several big Internet sites within a few years. The purpose of this paper is to spark debate about how this ambitious, but realistic, vision can best be achieved [3].

The Trends

There are numerous trends affecting the activities of Internet technology:

I. Bandwidth:

Astounding volumes of fibre are laid down by the telecommunications industry. Although Internet traffic is increasing exponentially, the bandwidth on the Internet infrastructure, as well as too many offices and communities, is enormous soon to be available. Nonetheless, too many end users of bandwidth would remain restricted by many technological factors. Many users can still connect to the old copper loop via a modem, or, at best, ADSL. Through low-bandwidth wireless networks, several other users can link. Most users may expect their desktop or palmtop to see no more than 128 Kbps to 1 Mbps available, although some asymmetric cable modems can exceed 10 Mbps (for downloads). Perhaps more significantly, the distance between the "edge" of the network's low bandwidth and the "backbone" of the network's high bandwidth will drastically increase as the backbone benefits from improved fibre quality and availability, while the edge remains hampered by the basics of wireless and copper connections. Even as local connections expand past 1 Mbps in the next few years, we expect this trend to continue, because backbone bandwidths are improving much faster than local bandwidths. (For instance, a 1.6 Tbps optical-fiber product has been announced by Nortel that will be out in 2000) [4].

II. Mobile devices:

Portable computing devices are one of the hottest fields of development in the computer industry. Anything from smartphones to palm computers to electronic books, from cars to telephones to pagers will have access to Internet services to perform user duties, even though users have no idea that such access is taking place. These devices would usually have unreliable, low capacity, high-latency links to the telephone or wireless network [5].

III. Mobile users:

Web-based email services1 make it clear that the ability to access your email from any device is essential to users. In public spaces, such as cafes, airports, and hotels, Web terminals will become commonplace. Ultimately, particularly with the increase in bandwidth, users would have full access from any terminal to all of their files and applications. Despite this, unregulated mobile devices will proliferate, because, as with public phones, Web terminals will never be accessible everywhere a user can find themselves [6].

IV. Intranets:

Protocols, particularly HTTP, are increasingly being used by organizations to create internal "intranets" for their own distributed information needs. A single entity controls all connections to an intranet. New technologies can thus be implemented rapidly, because (1) there is a need for little coordination with outside organizations, and (2) there is less concern about security (within the intranet).

V. Information overload:

Internet users are now frustrated by the sheer amount of information available, and as the Internet expands, the problem will get worse. Existing technologies that enable the user to reduce the torrent to a manageable stream are search engines, shop-bots, portals, collaborative filtering, and email filtering, but those technologies are still very restricted [7].

VI. Customization:

The Internet makes it possible, unlike broadcast media, to customize access for each user. For both the client (browser) and the server, current technologies allow customization. Many websites offer their own site-specific customization capabilities, but third-party "proxy" sites are increasingly providing the customization [7].

VII. Proxies:

These proxy sites, which are most frequently Web sites today, such as different shop-bots, communicate between a user and one or more other Internet services. Proxy sites will become more and more important as a way of both reducing information overload and customizing service access. In particular, highly specialized proxy sites will be provided to meet the specific needs of mobile users as handheld devices become more prevalent [8].

The Technical hurdles:

There are numerous technical hurdles which must be removed before mobile agents can be extensively used.

1. *Performance and scalability:*

Present mobile agent systems, at the cost of higher loads on the service machines, save network latency and bandwidth because agents are always written in a (relatively) slowly interpreted language for portability and security purposes, and because agents must be injected upon arrival in a suitable execution environment. Thus, mobile agents (especially those who need to conduct just a few operations against each resource) often take longer to perform a task than more conventional implementations in the absence of network disconnections, because the time savings from avoiding intermediate network traffic are currently less than the time penalties from slower execution and overhead migration. Fortunately, considerable progress has been made in compiling just-in-time (most notably for Java), isolating software faults, and other techniques that allow mobile code to run almost as fast as code compiled natively. Moreover, study groups are now aggressively investigating ways of reducing overhead migration. Together, these efforts could lead to a system in which only marginally more load is involved in accepting and executing a mobile agent than if the service machine provided the functionality of the agent as a built-in, natively compiled procedure [9].

2. *Portability and standardization:*

Almost all mobile agent systems allow a programme to pass freely between heterogeneous machines, e.g. the code is compiled into some platform-independent representation, such as Java byte codes, and then either compiled into native code or executed within an interpreter upon arrival at the target machine. However, the code must be flexible through mobile-code systems for mobile agents to be widely used, because it is impractical to expect the programming world to settle on a single mobile-code system. It will take a major standardization effort to make code portable across systems. The OMG MASIF norm is an initial step, but deals only with cross-system communication and administration, resulting in a situation where the agent is unable to move to the desired computer, but only to the nearby machine running the "right" agent system. The next step must be taken by the mobile agent group to standardize such unique execution environments (such as a particular virtual machine) as well as the format in which a migrating agent's code and status are encoded [10].

3. *Security:*

Once the technical challenges have been met, there remain several non-technical issues that may deter the widespread adoption of mobile-agent technology. Internet sites must have a strong motivation to overcome inertia, justify the cost of upgrading their systems, and adopt the technology. While the technological arguments above are convincing, they are not sufficient for most site administrators. In the end, the technology will be installed only if it provides substantial improvements to the end-user's experience: more useful applications, each with fast access to information, support for disconnected operation, and other important features. Fortunately, groups are now investigating several new approaches, each of which addresses (or 4Many mobile agent systems reduce the access rights of an agent when it arrives from a computer that is not trusted, even though it was launched at a trusted site by a trusted user. The risk is that one of the three issues could have been maliciously changed at the untrusted site (e.g., agents paying for resource usage with electronic cash, which allows them to live and propagate only as long as their cash supply holds out). Although more technological advancements (and user education efforts) need to be made before these three problems are adequately solved for all Internet applications, current work is sufficiently optimistic that mobile agent systems will be sufficiently safe for many applications within a few years.

CONCLUSION

In many Internet applications, there is a good argument for the use of mobile agents. There is, however, a simple evolutionary direction that will take us in the next few years from current technology to widespread use of mobile code and agents. The use of mobile agents will grow rapidly after many technological challenges have been overcome and a few innovative sites have installed mobile agent technology.

Once the technological challenges have been met, a range of non-technical problems remain, which may deter the widespread adoption of mobile agent technology. In order to conquer inertia, justify the cost of updating their systems, and embrace the technology, Internet sites must have a strong incentive. Although the above technical reasons are compelling, for most site managers, they are not adequate. Ultimately, the system can only be installed if it makes major enhancements to the experience of the end-user: more useful software, each with easy access to information, disconnected operation support, and other essential features.

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